

**BELLCOMM. INC.**

955 L'ENFANT PLAZA NORTH, S.W.

WASHINGTON, D. C. 20024

B70 06055

SUBJECT: Operational Envelope for a  
Possible Apollo 15 Exploration  
Mission at Littrow  
Case 320

DATE: June 15, 1970

FROM: P. Benjamin

ABSTRACT

The operational envelopes for a possible Apollo 15 mission to Littrow are defined by allocating the time required for all non-traverse activities and determining the time remaining for the traverses. Two EVA's are planned for, and mission planning is based upon the accomplishment of all surface objectives within the nominal EVA.

The primary geological objectives at Littrow are:

1. Sample mare material and compare it with that returned by Apollo 11.
2. Observe, photograph and sample the ridge structure.
3. Sample the mantling material and determine its age and composition.
4. Investigate the contact between the ridge and mantling with particular attention to age sequence.

The 40 minutes available for a geological traverse in the nominal EVA 1 may be used to meet the first objective. Inclusion of the Heat Flow Experiment in the ALSEP complement would eliminate the time available for a geological traverse on this EVA. A circuit consisting of 1.2 hours of walking and just under 1 1/2 hours of scientific activities at sampling stations may be used to accomplish the three remaining geological objectives on the second EVA.

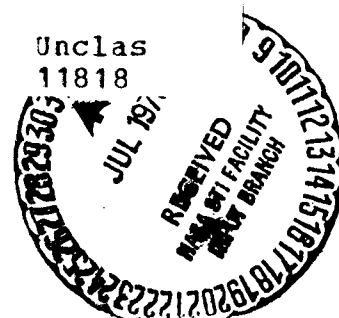
If a third EVA were to be considered, it could be used to visit the Serenitatis Bench, to reexamine interesting observations made on previous traverses, or to investigate other areas of interest. Consideration may also be given to deployment of ALSEP on EVA 2 or to splitting deployment between the first two EVA's.

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POSSIBLE APOLLO 15 EXPLORATION MISSION AT  
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MEMORANDUM FOR FILE

The operational envelopes for an Apollo 15 mission to Littrow\* are defined by allocating the time required for all non-traverse activities and determining the time remaining for the traverses. It is assumed that the surface timeline format will be the same as that which is planned for use on Apollo 14, with appropriate changes to account for differences in hardware and configuration. Two EVA's are planned for, each nominally 4 hours in length, with possible extensions to 4 1/2 or 5 hours in real time. This assumes the availability of only the -6 PLSS. Mission planning is based upon the accomplishment of all surface objectives within the nominal EVA.

EVA TIMELINES

The first EVA, shown in Figure 1, is devoted largely to ALSEP deployment and required overhead activities. ALSEP on Apollo 15 is essentially the same as that planned for Apollo 12 -- the Array A configuration. Activities associated with ALSEP require just under 1 1/2 hours. Some consideration is being given to the inclusion of the Heat Flow Experiment (HFE) to the ALSEP complement. This would extend the ALSEP related activities by 40 minutes. As on Apollo 14, the Modular Equipment Transporter (MET) is deployed early in the first EVA and is used to carry the hand tools, samples and sample bags, but not ALSEP, on all traverses. After all other activities are accounted for, only 40 minutes remain for a geological traverse on the nominal EVA 1. If the HFE is added to this mission, no time remains for a geological traverse in this EVA.

Only a few experiments are conducted near the LM in the beginning of EVA 2, shown in Figure 2. The 5 minutes allocated to MET loading may be used for LRV related experiments with the MET if its configuration at the termination of EVA 1 is adequate for immediate use in EVA 2. The nominal traverse is 2 hours and 35 minutes long, after all other activities have been provided for.

TRAVERSE OBJECTIVES

The landing site proposed by GLEP is near the crater

\* Littrow is currently one of several candidate sites under consideration for Apollo 15.

Littrow B at the Serenitatis Bench on the eastern edge of Mare Serenitatis. The Serenitatis Bench, a plateau between the mare material and the rugged highlands which surround Mare Serenitatis, is covered by a dark material, or mantling, which seems to extend into the mare. A fresh wrinkle ridge extends from the mare through the mantling material to the bench in the immediate vicinity of the landing area (ref. 1 and 2). The geometry of the area is shown in Figure 3.

The primary geological objectives of a mission to Littrow (ref. 1, 2, and 3) are:

1. To sample the mare material and compare it with the material returned by Apollo from Mare Tranquillitatis, to the immediate south.
2. To observe, photograph, and sample the structure of the ridge.
3. To sample the mantling material and determine its age and composition.
4. To investigate the contact between the ridge and mantling and determine the age sequence.

The first objective can be met in the area of the LM landing point, in the mare. The second objective can be achieved by a traverse along the ridge such as between points A and B in Figure 3. A traverse between B and C would meet the third objective, and the fourth objective is met at Point B.

#### TRAVERSE ENVELOPE

Since only 40 minutes are available for a geological traverse in the nominal EVA 1 timeline, neither the ridge nor the mantling is accessible during this EVA unless a decision on extension of the EVA can be made early in the EVA. In any case advanced planning of an EVA 1 traverse to these features cannot be performed with a 4 hour EVA. Thus, the first traverse is limited to meeting the first objective--sampling of the mare material. The three other objectives must then be met on EVA 2, probably in a circuit going, roughly, from the LM to points A, B, and C and back to the LM, or the reverse.

Assuming that the MET neither increases nor decreases the astronaut walking speed of 3.3 km/hr, the circuit of approximately 4 km requires about 1.2 hours of actual walking by the astronauts. This leaves just under 1 1/2 hours to be utilized for geological and geophysical tasks at the traverse stations, either at the points A, B, and C, or at any points between them. The direction of the traverse may be determined by the manner in which extension of the EVA would be used. Since the decision on extending the EVA would probably come

relatively late in the traverse, the area in which an extension can be most profitably used should fall in the latter portion of the traverse. If, for instance, it would be desirable to spend this extension at the ridge, the direction of the traverse would probably be clockwise from C to B to A.

The Serenitatis Bench, a little less than 4 km east of the landing point, may be within the operational limitation of the B/SLSS, depending upon final decisions regarding maximum emergency return walking rate and time available on the B/SLSS. If a third EVA on Apollo 15 were to be considered, approximately 1/2 hour could be spent at this objective. Alternatively, a third EVA could be used to reexamine points of interest noted on EVA 2 or to investigate other areas of interest not visited in the earlier traverses.

Objectives 2, 3, and 4 may be moved close together in the vicinity of point B. The closer they are moved together, the less diversity is examined in the traverse, but the more time is available for sampling due to a reduced walking requirement. If the points are moved far enough apart so that only an excessively small amount of time is available at each during a single circuit, the possible advantages of a split ALSEP deployment begin to be attractive. By splitting ALSEP deployment over 2 EVA's, 2 shorter traverses going in opposite directions can be constructed instead of the single circuit. This tactic has the disadvantage, however, of requiring more walking time in areas of lesser scientific interest (the mare) than a circuit.

#### CONCLUSIONS

For a possible Apollo 15 mission to Littrow, the 40 minutes available for a geological traverse in a nominal length first EVA restrict this traverse to sampling of the mare material in the immediate vicinity of the LM. If the HFE is added to the ALSEP complement no time remains in the nominal first EVA for a geological traverse. The 2 1/2 hours available for a geological traverse in EVA 2 permit slightly less than 1 1/2 hours of scientific activity at the remaining primary objectives--the ridge, the mantling, and their intersection--and just over 1 hour of travel between the points of interest.

A third EVA, if approved, could be used to visit the Serenitatis Bench, to reexamine interesting observations made on previous traverses, or to investigate other areas of interest. Evaluation of the options to deploy ALSEP on the second EVA or to split ALSEP deployment between EVA 1 and EVA 2 may reveal benefits in geological traverse planning. Such a switch in ALSEP deployment would, however, require reordering of the

mission priorities. If the -7 PLSS were available for Apollo 15 and surface staytime were extended sufficiently to utilize its capability effectively, 2 EVA's on the order of 6 hours could be planned, providing significantly greater time for geological sampling. It is questionable, however, that this added capability could be used to as great advantage at Littrow as at alternate landing sites, and consequently the availability of the -7 PLSS for Apollo 15 may tend to make other sites considerably more attractive.

2032-PB-meh

  
P. Benjamin

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2. F. El-Baz, personal communication.
3. T. Hait, presentation at the 24th Lunar Surface Operations Planning Meeting, March 20, 1970

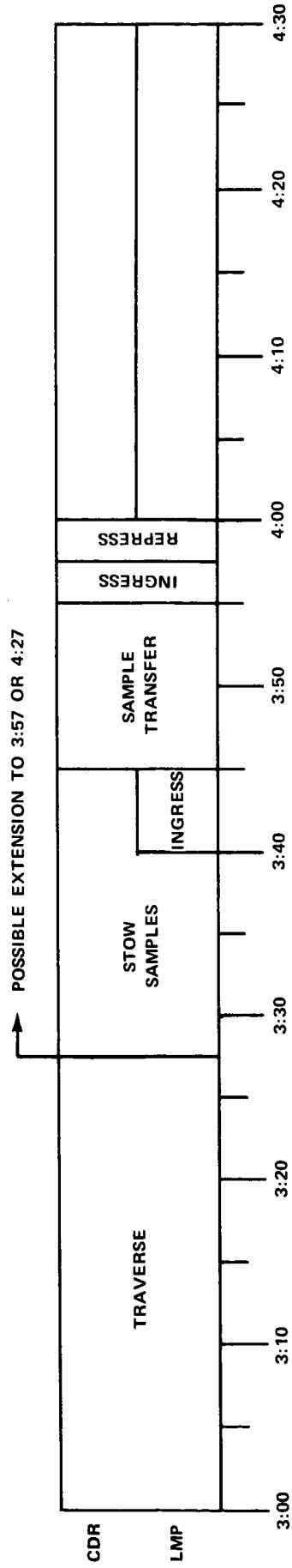
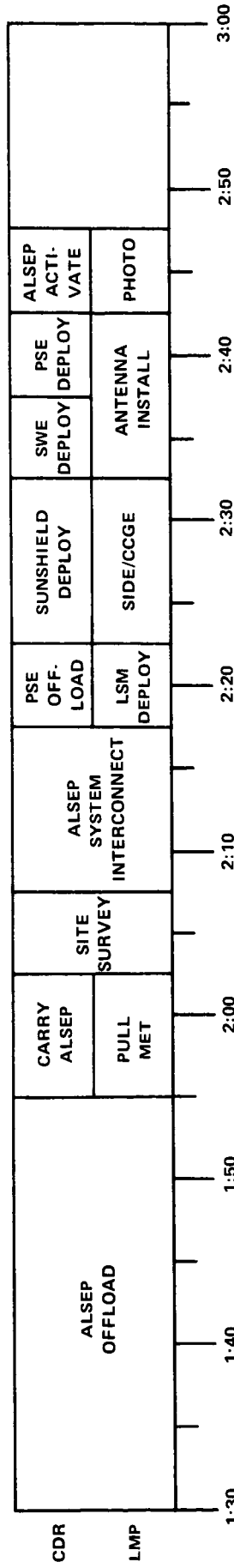
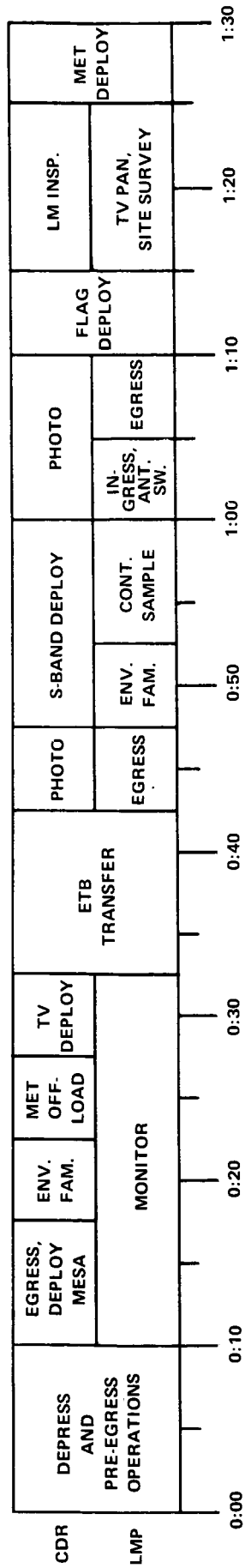


FIGURE 1 - APOLLO 15 EVA I TIMELINE

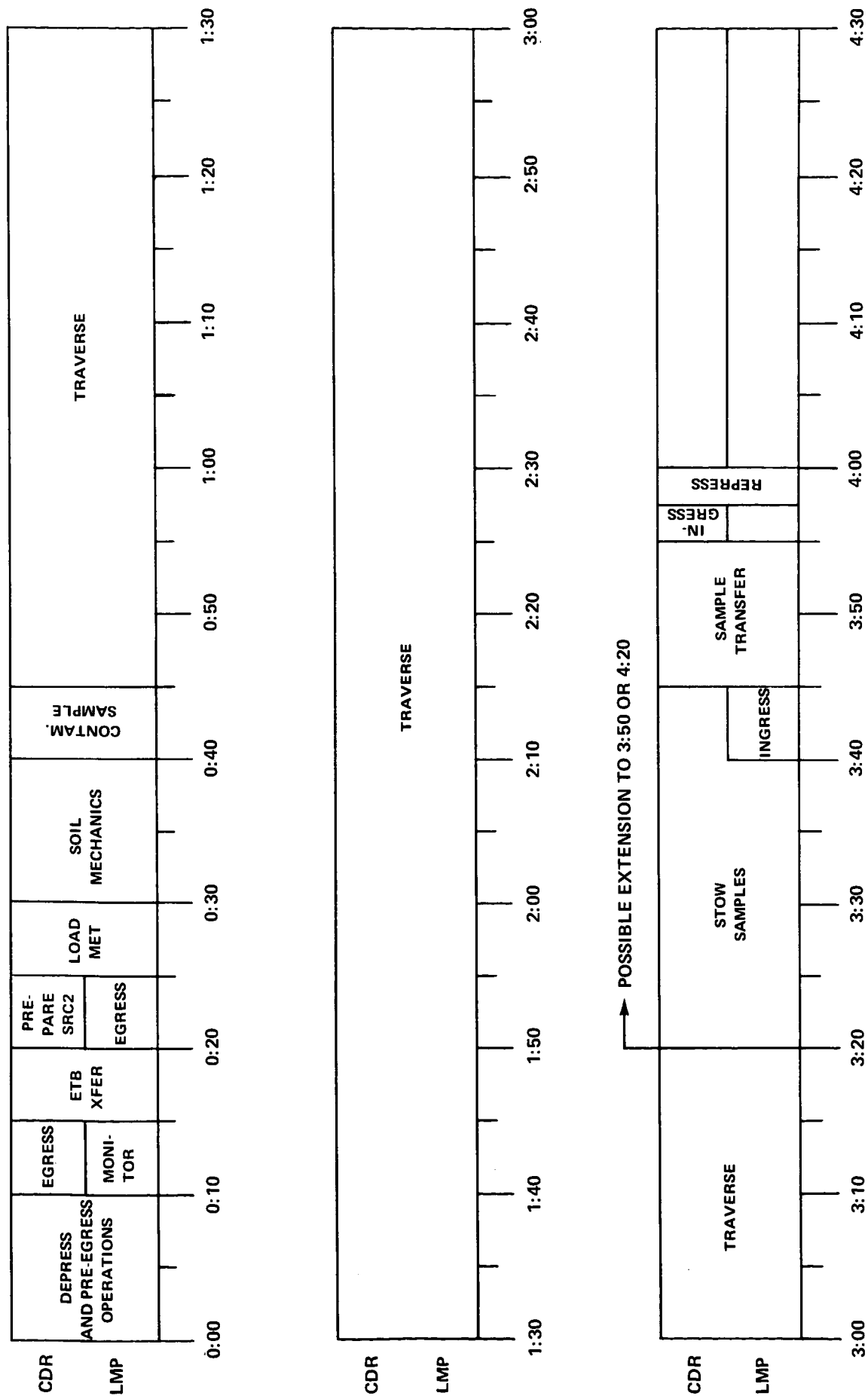


FIGURE 2 - APOLLO 15 EVA 2 TIMELINE



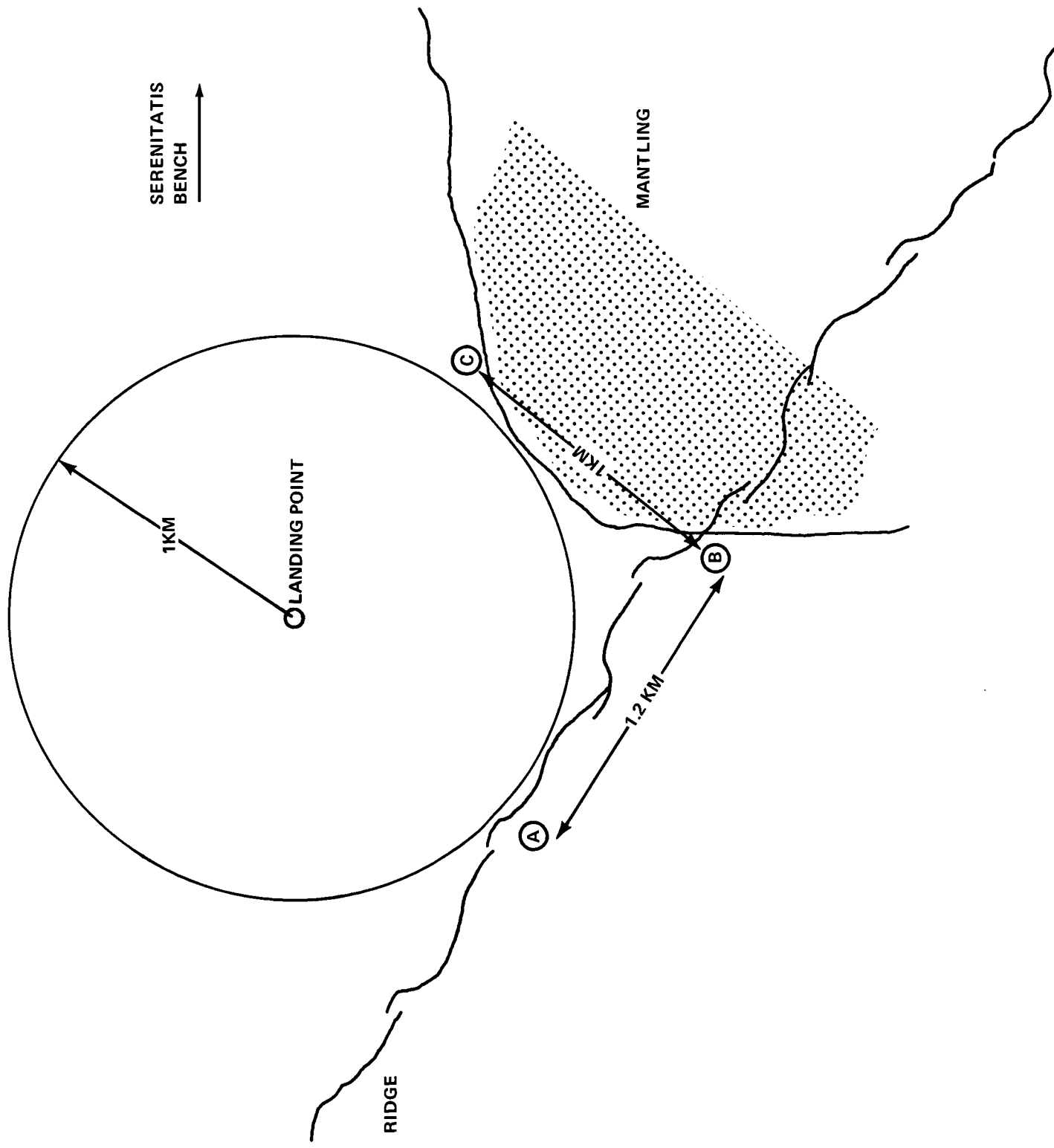


FIGURE 3 - LITTROW

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